Equipment Evaluation and Design of a Geologically-Oriented Photographic Facility for the Department of Geology and Mineralogy at The Ohio State University

SENIOR THESIS-- Presented in fulfillment of requirement for the
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ABSTRACT

Today photographic techniques are being applied to scientific studies of all types. The first portion of this report includes the history, basic principles, and geological applications of photography. The remainder of this report pertains to the design and equipment of a geologically-oriented photographic facility for the Department of Geology and Mineralogy at The Ohio State University.

INTRODUCTORY MATERIAL

INTRODUCTION

Photography can be a useful tool to the scientist. The Department of Geology and Mineralogy at The Ohio State University had preliminary plans for establishing a photographic facility within the department. This study was undertaken as an aid to designing and equipping the facility.

The first phase of this study was a survey of the various types and quantities of photographic work required in the department. This survey showed (Appendix A) that, on a quarterly average there was a need to get 488 prints (assorted sizes) and 1,439 color slides (copies and originals) produced in the darkroom section. In the studio section, 25 photographs would be shot and 451 slides reproduced along with many close-ups and microphotographs.

The next step in the study was the designing of an efficient darkroom and studio. Research in this area included study of many darkrooms and studios, plus reading appropriate books on the subject. After this research was completed, the plans were drawn up.

An evaluation of suitable equipment for the facility was a third step in this study. Many prices of photographic equipment were tested and checked. Evaluations were made on each piece and a recommendation as to the best in each category was made.

The first portion of this report includes a brief review of the history, basic principles, and geologic applications of photography. The major portion of this report deals with the design and equipment of a geologically-oriented photographic facility.

HISTORY OF PHOTOGRAPHY

The history of photography covers a period of a little more than 150 years. The first photographic negative ever produced by a camera is believed to have been taken by a French scientist named Joseph Niepce in the year 1816. This first negative was made on sensitized paper and was used to produce only one print. Several years after this event Niepce formed a partnership with Louis Daguerre and the two men invented a process by which a positive image was recorded by a crude camera on a metal plate coated with silver iodide (Merit Student Encyclopedia, 1970).

In 1839, the British scientist William Fox-Talbot invented a paper-based negative with a "fixed" image from which any number of prints could be made. Several years later another British scientist Frederick Archer invented the collodion wet-plate process. In this process a glass plate was coated with a light-sensitive compound suspended in a collodion, the exposure was made with the wet plate, and processing was carried out in a tent. The tintypes are a variation of the Archer process using black metal plates rather than glass.

In 1871 a dry-plate process was invented by a British physician named Richard Maddox. This process used a gelatin-based emulsion of silver bromide as the light sensitive material.

The first successful flexible roll film, with a cellulose base, was invented in 1887 by an American, Hannibal Goodwin. The following year George Eastman began marketing the Kodak camera for amateur use.

The emulsions up to this time had been orthochromatic, but after 1923, when the German chemist Ernst König discovered cyanide dyes, panchromatic films became available (Photographer's Mate 3, 1961).

In 1935 the Germans introduced the first 35-millimeter camera and film to the world. Also, in 1935 George Eastman introduced the first color film that gave faithful color reproduction and was simple to use, Kodachrome (American Peoples Enclyclopedia, 1970).

Instant photographs came into being in 1948 when the American scientist Edwin Land began marketing the Polaroid camera and films. In 1963 Polaroid introduced its first color film, and nine years later introduced the first plastic-based Polaroid film which fits their SX-70 camera series.

Today, photographic techniques can aid a scientist in his work by allowing the recording of an event in time. This gives the scientist more time to study the event and make his analysis or decision.

BASIC PRINCIPLES OF PHOTOGRAPHY

According to Webster, photography is the art or process of producing images on a sensitized surface by the action of light or other radiant energy. Photography, like any other art form, has basic principles that should be understood by everyone involved in photographic work. These principles involve the film, the camera, developing the film, and printing the image recorded on the film.

The film is a light sensitive material consisting of an emulsion and a base (Figure 1). The emulsion is the light sensitive portion, which records the image. It is composed of grains of a silver halogen salt suspended in a thin layer of gelatin. The silver halogen undergoes a slight internal change when exposed to light and records the image. The base acts as a support for the emulsion and can be made of almost any material. Paper, glass, plastics and metals have all been used as base materials, but cellulose derivatives are the most common (Photographer's Mate 3, 1961). The film is inserted in a camera to record a sharp, clear image.

The camera is an instrument that basically consists of a lightproof compartment with a device for holding the film at one end of the compartment and a lens fitted with a shutter and diaphragm at the other end (Photographer's Mate 3, 1961). Light reflected from the scene or subject to be photographed is admitted into the compartment when the shutter control is depressed. The light passes through the lens and strikes the film. The size of the diaphragm and the type of lens used determine the clarity and sharpness of the image (Figure 2). Once the film is exposed it must be developed to get an image.

The developing process (Figure 3) is carried out in total darkness since the film is light-sensitive. Developing the film to get a negative image involves a chemical reduction of the exposed silver halogen to metallic silver. After the developing is complete the film is treated with a weak acid solution or stop bath to neutralize the developing agent. The next step is to permanently retain the image by fixing the film. The fixer contains an agent which is a silver halogen solvent. This solvent, generally sodium thiosulfate, removes the unexposed silver halogen by combining with it to form water soluble sodium-sodium thiosulfate compounds. These compounds are removed by washing the film in water (Basic Developing, Printing, and Enlarging with Kodak Materials, 1957). After washing, the film is allowed to dry in a dust-free area before printing.

To make an enlargement, the dried negative is placed in the enlarger with the emulsion facing down. Light-sensitive paper is placed so that the emulsion will intercept the light projected from the enlarger (Figure 4). The exposure is made; the paper is removed and developed. Development for paper (Figure 5) is basically the same as for film, but with a few chemical changes in the solutions (Enlarging in Black-and-White and Color, 1967). A developer, a stop bath, a fixer, and final wash are used. After the print has been washed it is dried either by applying heat to it or allowing it to air-dry.

All of the developing and printing processes are carried out in a darkroom which may be especially designed for these operations.

Figure 1 Generalized cross-section of photographic film.

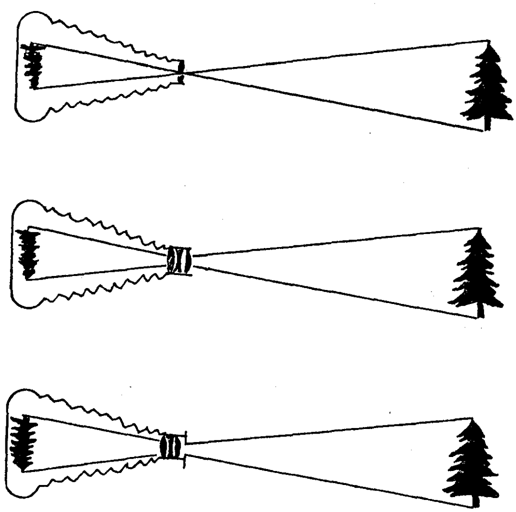


Figure 2 Various lens types showing that resolution is increased as more elements and a diaphragm are added.

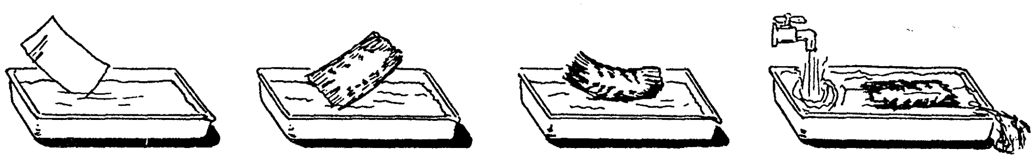


Figure 3 Steps involved in film processing.

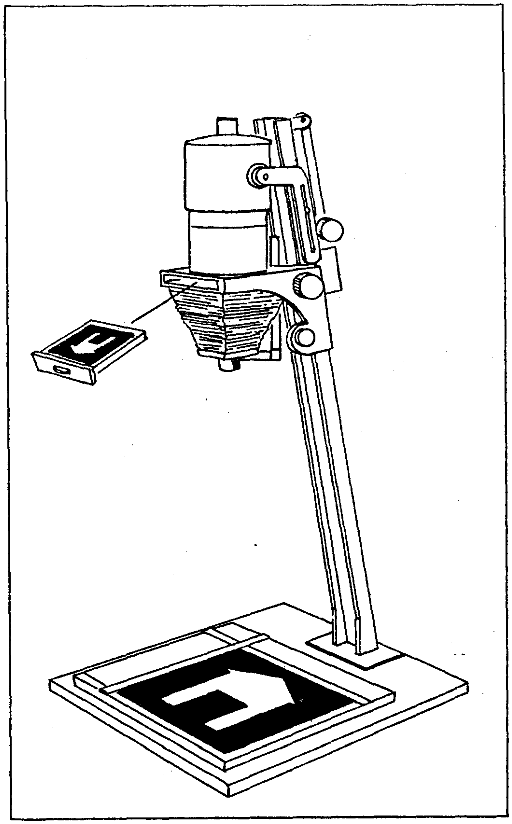


Figure 4 Relationship between the negative, the enlarger, and the projected image.

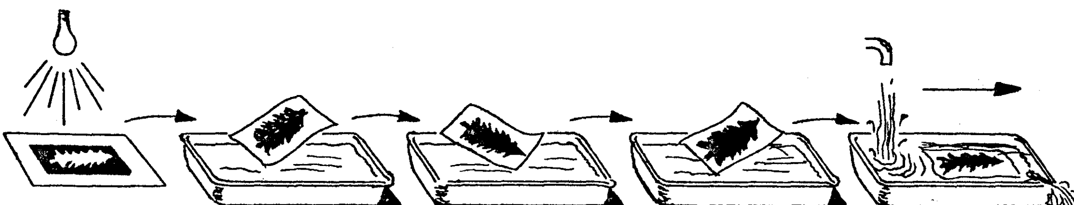


Figure 5 Steps involved in print processing.

GEOLOGIC APPLICATIONS OF PHOTOGRAPHY

Photographic techniques, when used properly, can be a great aid to the geologist. Geologists can use basic techniques in the field and specialized techniques in the laboratory or office.

In the field a geologist might want to take a photograph of a rock exposure (Figure 6), structure, or panoramic view for later study in the office. Also, the orientation of a fossil, a rock specimen, or joints might be photographed for further study. The only things required to take these photographs are a camera plus the knowledge of basic photographic techniques in lighting, perspective, and exposure. For the geologist who uses a 35-millimeter reflex camera, a knowledge of depth of field along with a close-focusing lens allows the taking of close-up photographs in the field. These close-ups show more detail than a general photo of the area or subject. Generally, a sequence of these photographs is taken for later study.

The first photo in the sequence is an overall shot of the area to show relationships and orientations. The second photo is a closer view of the particular area of interest. The final shot is a close-up of the area to show as much detail as possible. These photographs can then be studied in the office at a later date and possibly used to illustrate an article.

In the office or laboratory many other photographic techniques may be used. Specialized close-ups, photomacrography, and photomicrography are all used extensively in various types of research. Special close-ups using x-rays, ultraviolet or infrared light sometimes show details in a specimen or sample that can not be observed in the field. Fossils and coalbeds can be studied by infrared close-ups, whereas minerals and rocks can be studied by ultraviolet close-ups. Photomacrography uses bellows units or extension tubes to give low-powered magnifications of the subject (Basic Scientific Photography, 1970). These magnifications usually range from 2 to 40 times the original. Macro-photography, when applied to geological objects, often reveals subtle differences in texture, grain size, or fossil structures that cannot be distinguished in the close-ups of the subject. Microphotography, which uses the optics of a microscope to focus the image on the film, is used in paleontology (Figure 7), mineralogy, and petrography (Figure 8). This technique shows minute details of the sample that can be seen only with the aid of a microscope. Microphotography as a geologic tool is invaluable in the study of micro-fossils because it shows these details. Besides these techniques many others can be used in geological work (Blaker, 1965).

Space photographs (photographs taken from space) are being used by the geologist in many ways. They are used by structural geologists to analyze regional structure. The geomorphologist uses them to analyze changes in the regions that are photographed. The economic geologist uses space photographs to evaluate large areas for possible geologic exploitation. The hydrologist uses them for planning regional water budgets and pollution control (Figure 9). Lunar and extraterrestrial geologists rely almost entirely on space photographs along with samples gathered by astronauts.

Aerial photographs are used by geologists in much the same ways as are space photographs. Aerials are used in evaluating or analyzing areas of mineral deposits, stratigraphy, structure and geomorphology (Figure 10). The only difference between aerial and space photographs is the area coverage of each print.

Submarine photographs are used by marine geologists to determine what is occurring under the surface of the oceans. Submarine erosion and deposition are analyzed by using photographs. Turbidity currents and sea-floor spreading are also studied using submarine photographs.

Today's geologist is aware that photography can be a valuable tool and is now developing better and more useful techniques for its geologic application.

Figure 6 Field Photograph

Figure 7 Photograph of a conodont (Approx. 40x).

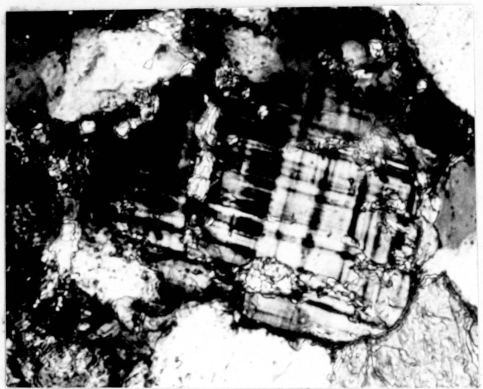


Figure 8 Photograph of a rock sample showing the mineral microcline (Approx. 140x).

Figure 9 Space Photograph

Figure 10 Aerial Photograph

DESIGN OF A GEOLOGICALLY-ORIENTED PHOTOGRAPHIC FACILITY

THE DARKROOM

The darkroom is the photographer's laboratory and as such deserves much consideration as to location, size, arrangement, color, lighting, ventilation, and water supply.

The criteria for locating a darkroom should be accessibility, average temperature, and local vibration. The first concern, accessibility, is the most important. The darkroom should be located in an area where it can be easily reached by anyone wanting to use the facilities. The average temperature of the room should be 65-75° F so as to provide a comfortable working temperature for the photographer. This temperature range also allows for the storage of photographic materials in the darkroom without risk of heat damage. The local vibration should be minimal since any vibration affects the quality of the prints produced in the darkroom. Besides location, size is also important in designing a darkroom.

The darkroom should be no larger than is absolutely necessary. A darkroom that is too large causes the photographer to walk many extra steps while working in the darkroom. This tends to slow down the production. On the other hand, a darkroom that is too small tends to cramp the photographer and to hinder his work (Photographer's Mate 3, 1961). A darkroom that is to be used by one or two people should be about 10 feet by 10 feet from wall to wall. This size room allows for the installation of 30 inch cabinets plus a counter along three of the walls and still leaves a 5 feet by 7 feet 6 inch open floor area for walking. This amount of room also lets the photographer arrange his equipment properly (Diagram 1).

The darkroom should have plenty of cabinet space and open counter area for photographic materials and equipment (Allen, 1941). The cabinets should be arranged so that drawers are near the enlarger. These drawers can be used for the storage of papers and enlarger accessories and aids. The counter should be arranged so that the sink is in the center section with an open counter on each side of the center section. This open counter areas lets the photographer arrange the enlarger, development trays, and print washer in an efficient way. Generally, prints are produced in a left to right order from enlarger to washer, but this counter arrangement also allows for right to left production. The counter should be dark-colored, but the walls should be light colored.

The idea of painting darkrooms black is old fashioned. The walls should be painted a light grey or green, using a semi-gloss paint which is easily washed, to reflect the maximum amount of "safe" light (Clark, 1939).

Lighting, both white and safelight, is very important in the darkroom. White light is necessary in preparatory operations and in cleaning the darkroom. Fluorescent lights should be located on the ceiling so that all of the room is well illuminated for these operations. The safelights, which emit safe, filtered light, should be bright enough to provide maximum visibility without fogging the photographic paper. Generally these lights require a 60-watt incandescent bulb. With light-colored walls, safelights mounted from the ceiling illuminate the room well enough to let the photographer easily see what he is doing. Yet, this amount of light will not fog the paper. Also, a small safelight should be mounted above the developing trays so that the photographer can clearly see the amount of development of the print in the chemistry. Since some photographic chemicals have an annoying odor the darkroom should be well ventilated.

The ventilation of a darkroom should consist of a blower unit located near the doorway and exhaust vents located above or behind the developing area. The blower unit forces fresh air into the darkroom and distributes it throughout the room. The exhaust vents permit the outflow of the "pressurized" foul-smelling and humid air by establishing an air-current over the developing area. If necessary, a dehumidifier can be installed to remove excess moisture in the room. This can be attached, by pipes, to the drain for the water supply in the room.

A water supply in the darkroom is essential. Water is used to wash prints and film, mix chemical solutions, and for cleaning purposes. The water supply should include hot and cold running water and a temperature control unit (Photolab Design for Black and White and Color Photography, 1967).

All of this and the choice of equipment determine whether the darkroom will be efficient to work in or not.

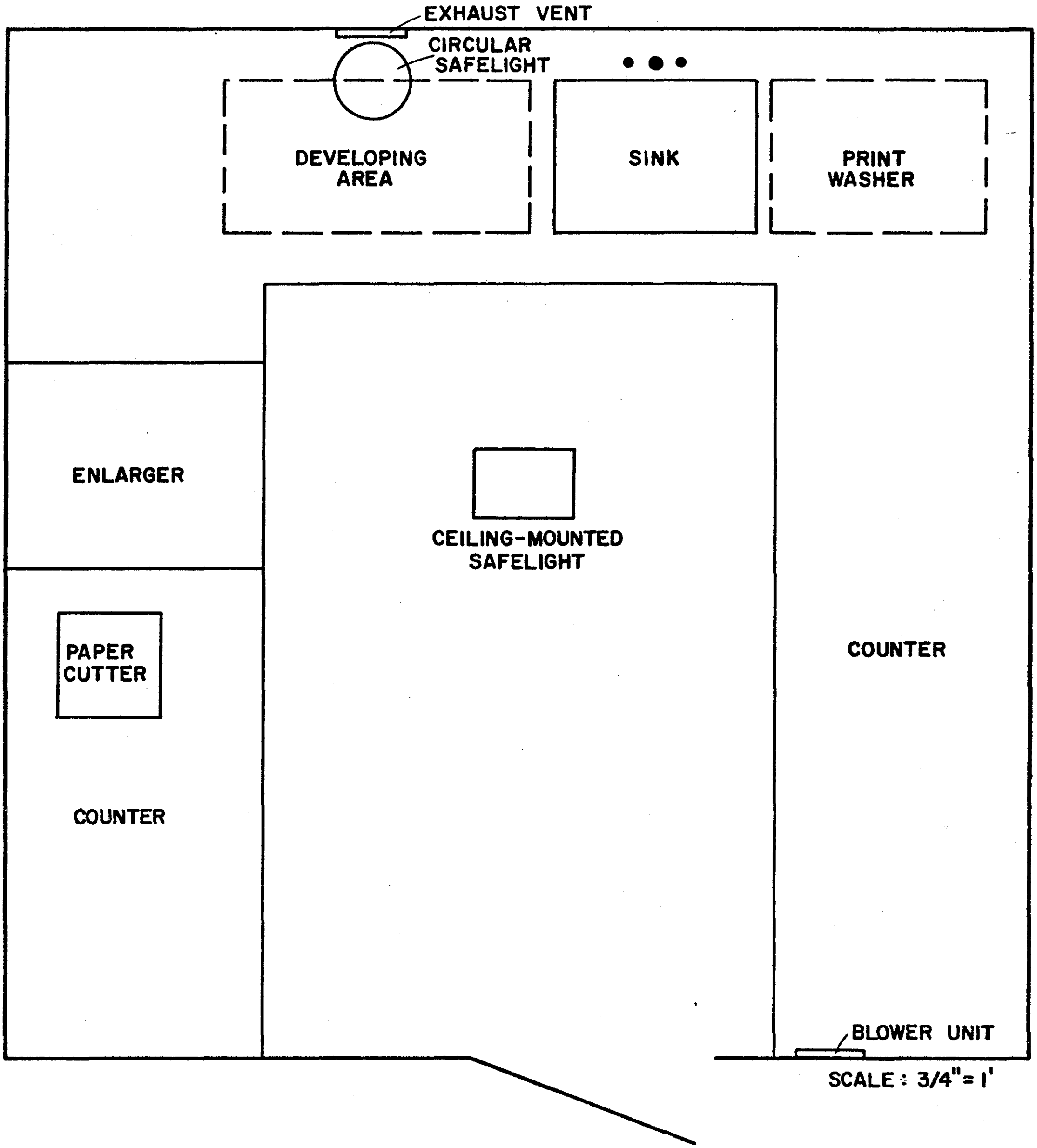


Diagram 1 An idealized darkroom arrangement.

THE ENLARGER

The photographic enlarger to be used in a geologically-oriented laboratory must meet certain criteria to perform with the precision that is required in the print making. These criteria are:

1.) A rigid frame supporting the enlarger head

2.) The ability to project at least a 20" x 24" image

3.) The capability to handle a 4" x 5" negative

4.) Relatively easy operation in any position

5.) The capacity necessary for making color prints

6.) The capacity to control line voltage fluctuations

All of the above criteria are important in respect to producing consistantly high quality prints in the lab.

A rigid framework is necessary to reduce any vibration that might be present. A single-beam, centrally located frame will amplify the vibration of the building. A double-beam, side located, well reinforced frame will reduce any vibration to a minimal amount. Also, this rigid structure allows for a higher frame to be used on the enlarger.

A high frame is needed to produce large-sized images because the greater the distance between the enlarger head and baseboard, the larger the projected image size. In geology, an image of at least 20" x 24" is required to reproduce maps, charts, and diagrams with an appropriate amount of the original detail. Also, a tilting head is valuable in making large prints since the image can be projected onto a wall. Large image size demands a large negative format to maintain the required resolution and detail in the print.

The smallest negative size that should be used for large sized prints is 4" x 5" so that the original detail is seen in the reproduction. For small prints, negatives of a smaller size are generally acceptable. Usually a greater number of small prints are produced in a photographic laboratory, yet, when large prints are being made all the controls for the operation of the enlarger should be easily accessible.

Easy operation and accessibility of controls are very important in evaluating an enlarger. In the darkroom the controls are generally not clearly visible to the operator; therefore, the controls must be located in such a way that they are easily found in the dark. Also, the operation of the enlarger must be relatively simple so that it will not hinder the operator and slow down print production. In color printing this is very important.

Although it is not likely that color prints will be produced in great volume in the laboratory, the enlarger should have the capability of holding color print filters or have a dichroic color head as an accessory. This capability allows for the small amount of color printing that might be required by a geology department. In color printing, any variation in the intensity of the light source can be disastrous.

The intensity of the printing lamp is controlled by the voltage of the electrical circuit. As the circuit voltage fluctuates, so does the lamp intensity. To control this, a rheostat is inserted into the electrical system between the main plug and the light socket. This voltage control lets the operator maintain a constant voltage in the line while printing.

After evaluating many types and brands of enlargers, it was determined that the Beseler 45 MCRX (Figure 11) is the best enlarger for a geologically-oriented photo lab. This enlarger offers a very sturdy and rigid double, side beam frame, a large projected image size, and a maximum negative size of 4" x 5". The Beseler enlarger is easy to operate since all of the controls are located in one area. Also, the enlarger can be used to print color work by substituting the dichroic head for the normal enlarger head and using the frame mounted voltage control which is supplied with the enlarger.

THE PRINT WASHER

The print washer is a much needed piece of equipment in a photographic laboratory. The washer should meet certain specifications to be effective in removing the fixer from the prints and still be long-lasting in its operation. These specifications are:

1.) A simple but effective system of water input

2.) A simple but effective system of water outflow

3.) Manufactured from a chemically inert material

4.) Simple operation and maintenance procedures

To perform satisfactorily in removing the fixer from the prints, the washer must have an efficient system of getting a sufficient amount of uncontaminated water to the prints. The best possible way to do this is to have the washer connected to the plumbing network such as a faucet. This allows a maximum amount of water to flow around the print and wash away the fixing agent. This contaminated water must then be removed.

The outflow spout or drain should be large enough to remove contaminated water without allowing an overflow. It should be designed so that it can be connected directly to the plumbing or drained into a sink. This contaminated water can be corrosive so the equipment should be inert.

An important property of a washer is that it is manufactured of a chemically inert material. Generally, this material is fiberglass or stainless steel. Both of these materials require little care or maintenance.

A washer should have as few moving parts as necessary to make it operate properly. The best type of washer is one that rotates due to water pressure on a vane at one side of the tank drum. This type rapidly removes the fixing agent and has only two bearings that might possibly need replacement. Other than this there is no maintenance or repair. The operation of this type of washer only requires turning on a faucet.

After evaluating many brands and types of print washers, it was determined that the Arkay Loadmaster 1620-A (Figure 12) is the best washer for a geologically-oriented photo lab. This washer delivers a maximum flow of water to the prints, rotates by water pressure, allows for a maximum outflow of the contaminated water, and is very simple to operate.

OTHER DARKROOM ACCESSORIES

Many items besides an enlarger and a print washer are needed in a darkroom. Some of these other necessary pieces are developing tanks, developing trays, graduates, and funnels (Figure 13).

Developing tanks, made of either stainless steel or plastic, are necessary to process films. These tanks are equipped with a reel which holds the film apart so that solutions may cover the entire roll of film. The tank is light-tight when the lid or cover is in place and may be used in white light without damaging the film.

Developing trays, generally constructed from plastics, are used to hold the solutions for print development. These trays come in rectangular sizes from 5 x 7 inches up to 30 x 40 inches. The best choices for ordinary work are 8 x 10 inches and 20 x 24 inches.

A large (32 ounces) and a small (4 ounces) graduate are necessary items in a well equipped darkroom. The graduates along with several sizes of funnels facilitate the mixing, measuring, and pouring of the many photographic solutions used every day in the developing of films and prints.

Storage bottles for the solutions, a thermometer, and film clips are also needed in a darkroom.

The bottles are used in the storage of the many solutions needed and used in a photographic laboratory.

A thermometer, for measuring the temperature of solutions, should be in the darkroom. The temperature of the film developer must be known so that the proper development time may be calculated for each specific film.

Film clips are necessary for hanging the film to dry after it has washed.

Many different types and brands are available in each of the equipment categories. Generally personal preference dictates the purchase of one type or brand over another. For this reason no recommendations as to types or brands of these items is being made.

Figure 11 Photograph of Beseler 45 MCRX enlarger.

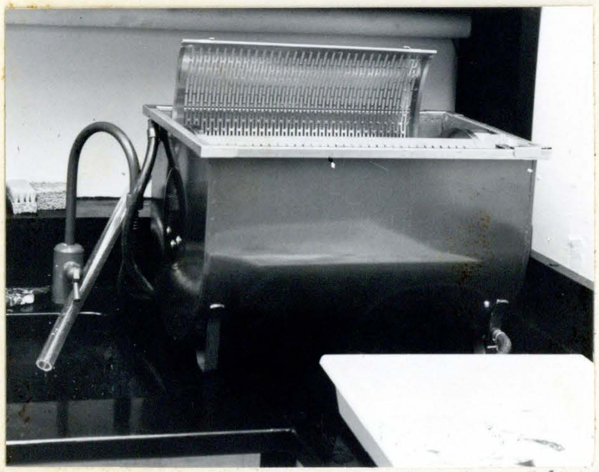


Figure 12 Photograph of Arkay 1620-A print washer.

Figure 13 Photograph of darkroom accessories.

THE PHOTOGRAPHIC STUDIO

The studio is as important as the darkroom when it comes to producing good negatives and prints of geologic specimens. Such factors as room size, lighting and arrangement must be considered as particularly important in the design of a geologically-oriented studio.

The size of the studio is not as critical as it is with the darkroom. Objects in the studio, such as lights and backgrounds, can be moved to provide more space in the area where the photographer is working. For a geologically-oriented photo facility, a studio size of 10 feet by 10 feet should provide ample working space. This size permits the installation of 30-inch wide storage cabinets and counter along 4 feet of one wall. This leaves 6 feet along that wall for the small desk and file cabinet that are required for the office work of the facility.

The lighting in the studio should be normal level. Ceiling mounted fluorescent lights provide the most even illumination. Each light should have a separate on/off switch. This lets the photographer turn off any light that might be producing glare on a specimen he is photographing, also, it permits the installation of specialized lighting such as infrared or ultraviolet. Two electrical outlets should be located on each wall so that lighting units and other electrical equipment may be used throughout the studio. Work areas can be arranged according to the lighting and outlet locations.

A copy area, a general photography area, and a specialized photography area are all required in the studio. The copy area, including a large format (4 x 5 inches) copy stand with lights for copying maps, etc., and a slide copier, should be located against one of the unused walls (Applied Color Photography Indoors, 1962). A small cabinet under the copy stand provides storage space for film backs, light bulbs and copying accessories. The general photography area, located against one of the remaining unused walls, should consist of a table, portable light units, and an upright cabinet. The table is for holding specimens while being photographed. The cabinet is for storing the specimen backgrounds, shadow box, light tent, and other items used in photographing geologic specimens and samples (Studio Lighting for Product Photography, 1959). The specialized photography area, adjacent to the general photography area, should include a table, a small cabinet, and a photomicroscope, and its accessories (Diagram 2). This area is strictly for Microphotography.

If additional space is not available the studio must also serve as a finishing room. A print dryer, a print drying rack, and a film drying cabinet may be installed on the counter top along the wall.

A studio of this design should permit the photographing of all geologic samples and specimens needed by geologists.

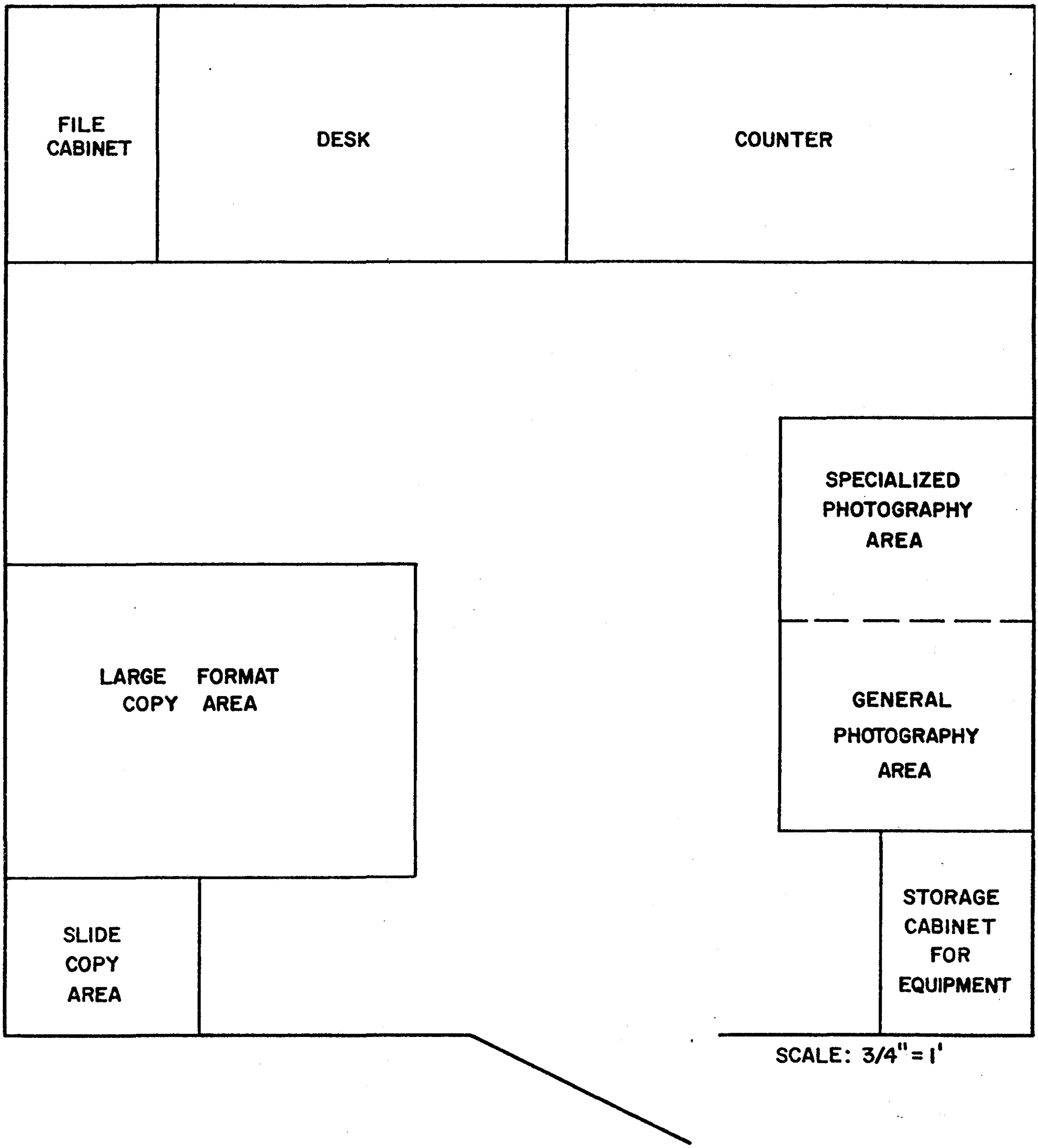


Diagram 2   An idealized studio arrangement.

THE CAMERAS

The camera for a geologically-oriented photographic section must be easy to use, durable, and versatile.

For normal work a 35-millimeter camera is best suited to do the jobs. The single lens reflex 35-millimeter camera is very easy to use after a short explanation of the controls; is generally well built, durable, and dependable and is very versatile when accessories are added to the system.

The system should include the camera body, a normal lens, a macro or micro lens, a bellows unit, and an assortment of focusing screens and viewfinders. Of all the cameras available that fall into this category, the Nikon F2 and the Canon F-1 seem to be the best choices.

The Nikon F2 (Figure 14) offers the latest in camera technology with an electronically controlled shutter and diaphragm. Shutter speeds range from 10 seconds to 1/2000 seconds. The Nikon also offers a choice of six viewfinders, twelve focusing screens, and more than forty lenses including a macro and a perspective control lens. In addition, the Nikon system includes bellows units, extension rings, and microscope attachments for close-up and microscope work.

The Canon F-1 (Figure 15) is basically the same as the Nikon with an electronically controlled exposure mechanism. The Canon system includes five viewfinders, four focusing screens, more than thirty lenses, bellows units, extension rings, and microscope attachment.

Either camera system would be ideal for geologically oriented photography since they are technically the same and offer the same accessories. For some types of work 35-millimeter cameras do not provide enough resolution.

The $2\frac{1}{4}$ x $2\frac{1}{4}$ inch or the 6 x 7 centimeter format cameras show more details than the 35-millimeter camera. This is because the lenses for the medium format cameras have a greater resoluting power. The best camera in this category is the Hasselblad 500 C/M (Figure 16). This camera has many accessories, such as interchangable film magazines, viewfinders, and special lenses, that would be valuable to the scientist in his work. The camera can function as a medium format copy camera but cannot be used to copy large size objects.

For copy and large format work a 4 x 5 inch view camera is best suited to do the jobs. Of those available today, the Linhof Kardan-color 4x5S seems to be the most versatile. This camera features unlimited swing movements through the center and 180-degree tilts at the bases of the front and rear standards. The camera is mounted on a monorail with a 16½ inch bellows. This camera is very easy to use, well built, and very versatile.

These two cameras, the 35-millimeter and the view camera, should permit photographs to be taken of almost any geologic samples or specimens as well as structural, geomorphological, and stratigraphical objects in the field.

THE PRINT-DRYER

The print dryer to be used in the laboratory must meet the needs of the lab. These needs are:

1.) The capability to dry a large volume of prints in a relatively short time

2.) The ability to be used for matte or ferrotype drying

3.) A simple disassembly/assembly procedure

4.) The ability to turn itself off after drying prints

All of these features are necessary to produce a large number of high quality prints.

The print dryer must have the capability to dry a large number of prints in a short time. This feature facilitates the smooth sequential operations from projected image to final print. If this sequence is slowed down by a dryer with a slow drying rate or a small drying capacity the lab technician will find himself with a large number of prints that need to be dried at the end of the day. This can be very time-consuming if the prints must be ferrotyped.

Ferrotyping is drying the print with a high gloss surface. Matte finish is drying the print with a low gloss surface. The dryer should have the ability to dry prints either ferrotype or matte finish. This makes the dryer more versatile in the lab by allowing the prints to be dried with various surface finishes. For ferrotype drying the drum must be polished to a high lustre.

To polish the dryer drum, the machine must be disassembled. For this reason it is imparative that the dryer can be taken apart and put back together easily. Also, this feature is an asset when repairs on the machine are necessary, such as replacing a warped or broken heating element.

A warped or broken heating element results when the heat intensity is too great when the machine is turned off. To avoid this occurence, a dryer should have a thermostatically controlled stop mechanism. With this feature, when all the switches on the dryer have been turned off the drum will continue to rotate until the units temperature is low enough so that no damage to the element will result from stipping the rotation.

After evaluating many brands and types of print dryers, it was determined that the Beseler Model 1620 (Figure 17) is the best dryer for a geological laboratory. This dryer can dry approximately fifty 8" x 10" prints per minute, can dry prints with matte or ferrotype finishes, is easily repaired and maintained, and has a automatic shutoff feature. All of these reasons plus its relatively small size make the Beseler dryer the best dryer for a geologically-oriented photographic laboratory.

ADDITIONAL STUDIO ACCESSORIES

As is the case with the darkroom, the studio has need of many items other than the cameras and their accessories to function properly. Some of these items can be made, such as the copy stand and slide copier. Other items, such as lighting units, paper cutter, and the photomicroscope, must be purchased.

The copy stand (Figure 18), used to copy documents, maps, and diagrams, can be made by a semi-skilled carpenter. The slide copier (Figure 19) can be made at the same time as the copy stand.

The lighting units should be portable, electric, and high intensity. The lights are used to illuminate specimens and samples while being photographed. For use in a geological photo facility, photofloods with seven inch reflectors should provide ample light for photographing even large samples.

The paper cutter, for cutting prints to the proper size, should be large enough to handle large prints. A twenty-four inch blade on a 20 x 24 inch baseboard ought to be large enough.

The photomicroscope should be reliable and easy to use. Since many types and brands are available, no recommendations will be made.

Many times the studio also serves as a finishing room. If this is the case, a print drying rack (Figure 20) and film drying cabinet (Figure 21) can be made by a carpenter for use in the studio.

Figure 14 Nikon F2 Photomic
35-mm camera.

Figure 15 Canon F-1
35-mm camera.

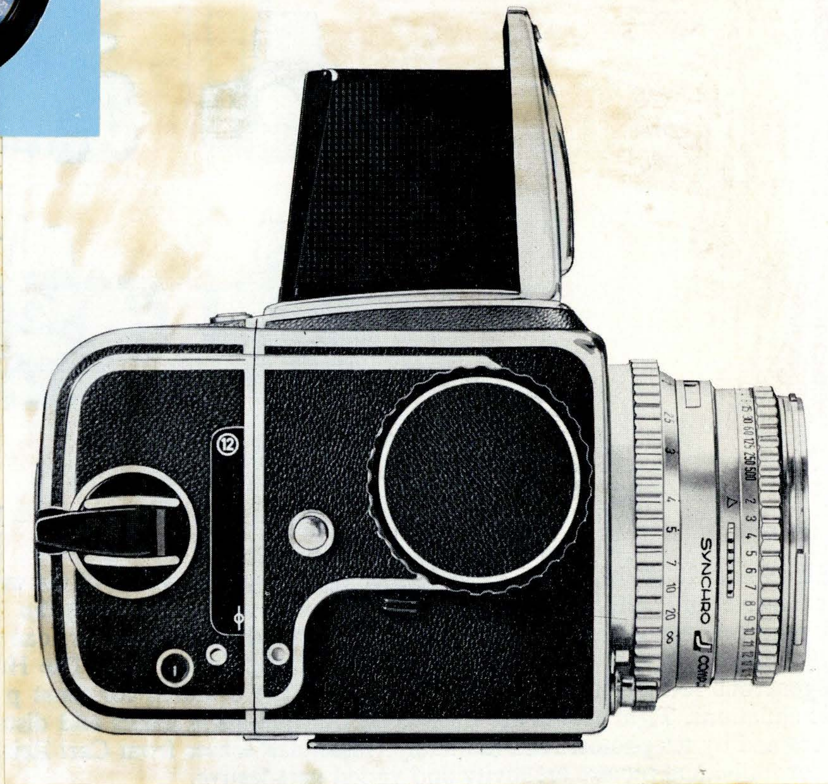


Figure 16 Hasselbald
500 C/M $2\frac{1}{4}$-square
camera.

Figure 17 Photograph of
Beseler 1620
print dryer.

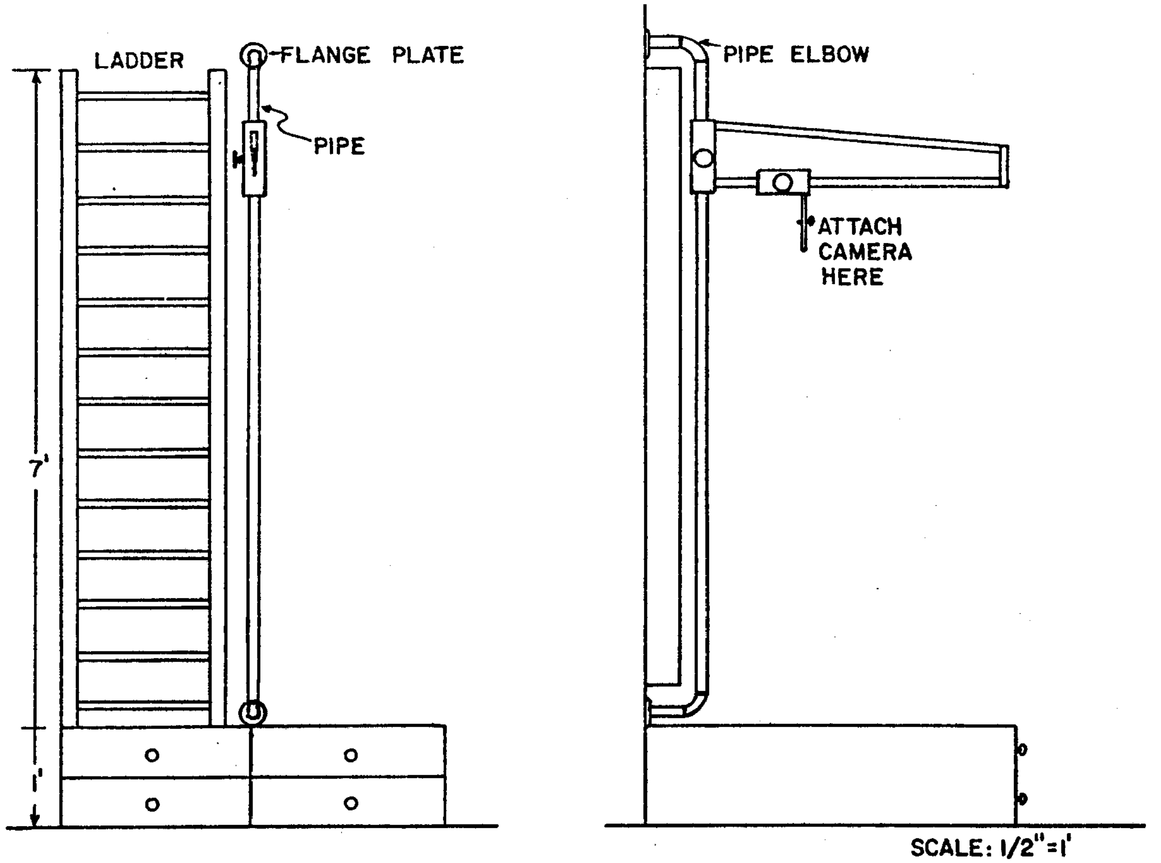


Figure 18 Illustration of a commonly used large-format copy stand arrangement.

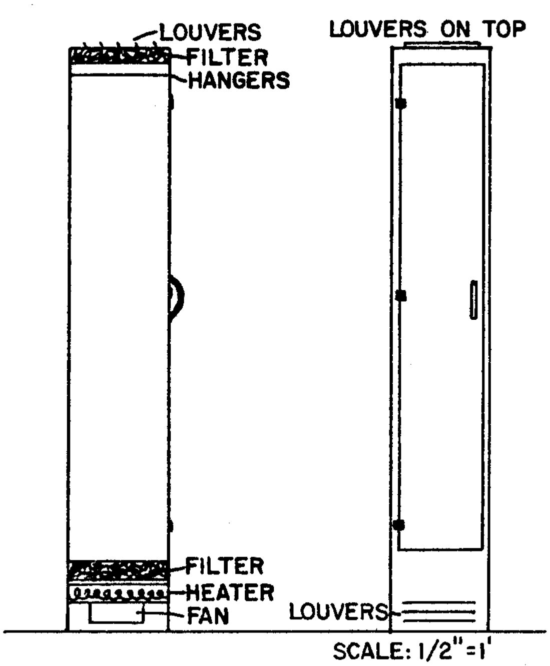


Figure 21 Film drying rack.

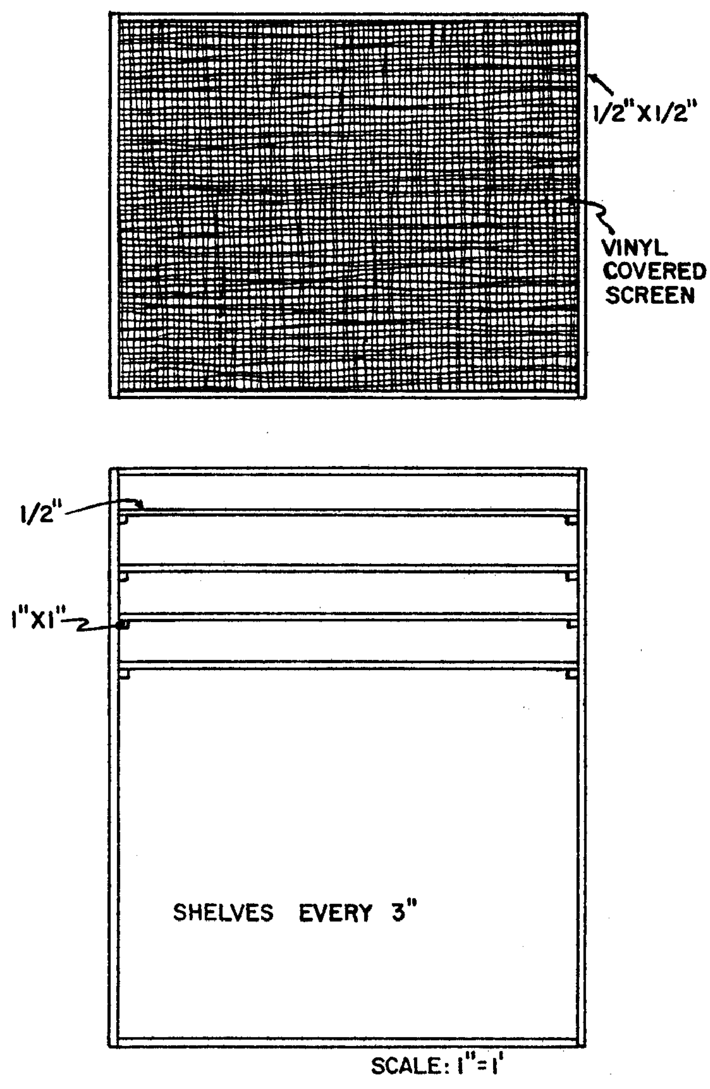
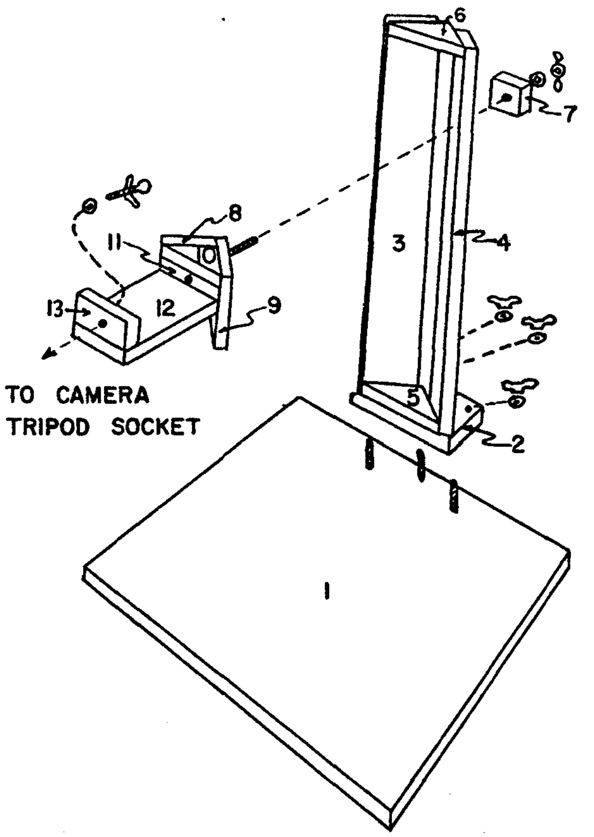
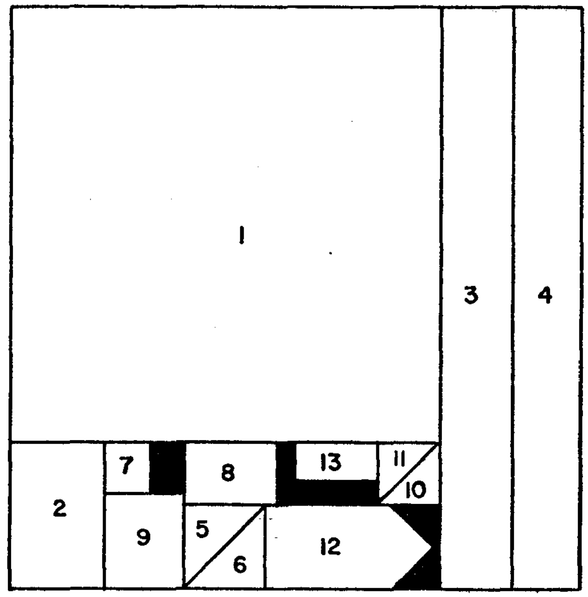


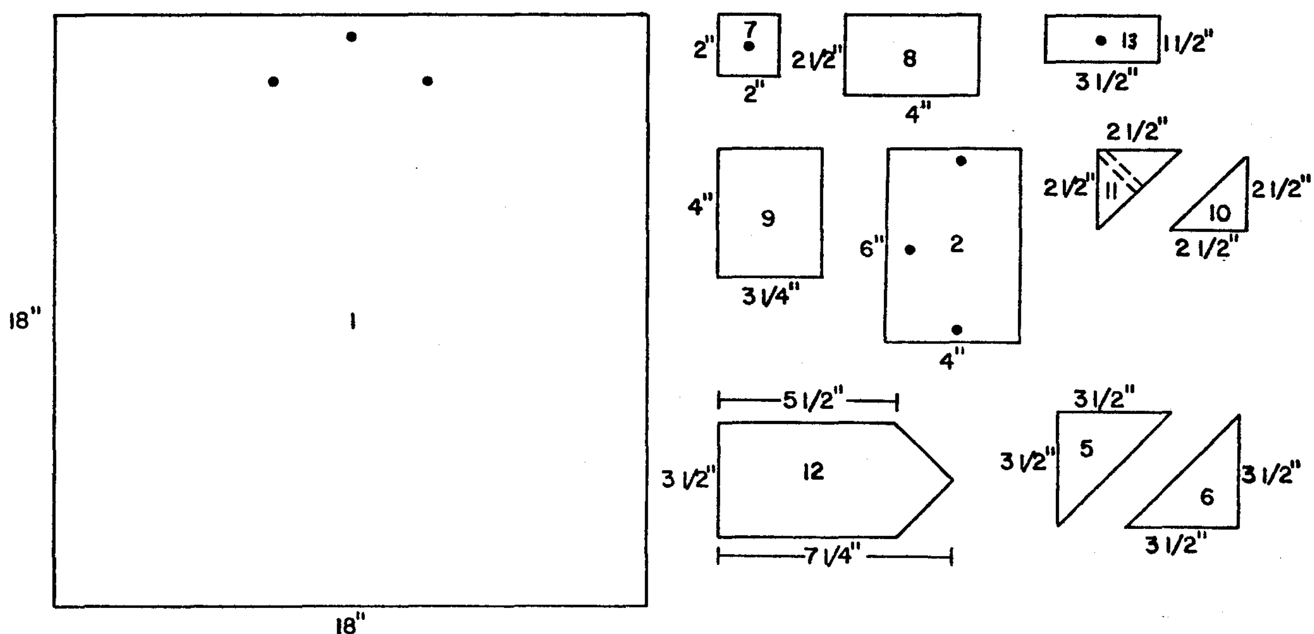
Figure 20 Print drying cabinet.

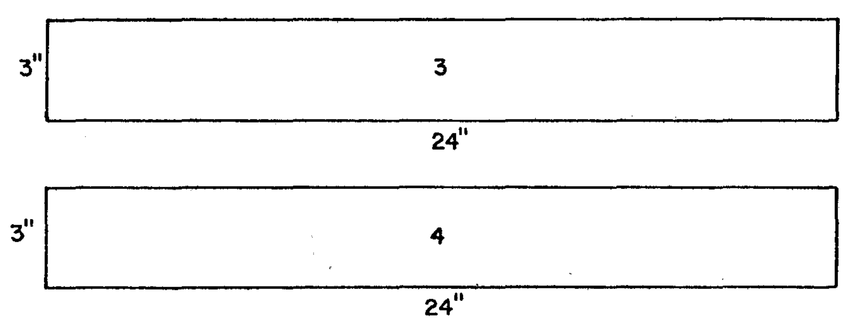
Figure 19 Illustration of the dimensions, cutting, and construction of a small copy stand.

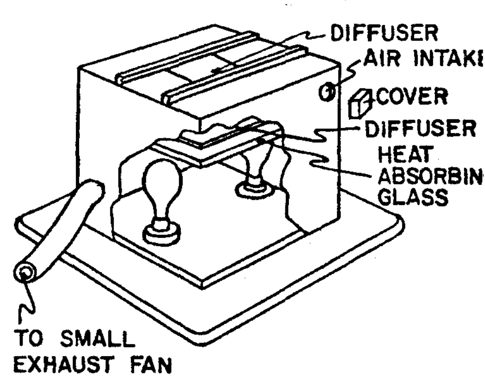
The drawing in the lower right corner of the page illustrates a simple slide copying box which can be mounted on the copy stand.











CONCLUSION

A darkroom facility now exists within the Department of Geology and Mineralogy at The Ohio State University. This facility was built during the summer of 1973 according to the idealized plans stated under the darkroom section of this report. The studio facility is still in the planning stage, but it should be completed by early 1974. In addition to the darkroom, a film changing room was built in a small area off the darkroom (Diagram 3).

The darkroom was established with a minimum cost to the department (Appendix B). The studio should also require a minimum expense to equip since much of the needed equipment will be made in the department maintanance shop.

Since the establishment of the darkroom, the use of photographs by members of the department has increased. The major areas of increased use are study and research. The use of photographs for publications and articles has also increased to a small extent. The facility is now an important part of the department for these reasons.

As can be seen in this example, a photographic facility can become a valuable part of a geology department. It provides a new medium of research to all phases and branches of geology, plus a much needed approach to teaching and study by using photographs and slides. To show geologic features and details that may not be readily available within the departments normal teaching materials.

I recommend that all geology departments evaluate their photograph requirements and study the possibility of establishing a photographic facility as a process of self-betterment in the fields of teaching and research.

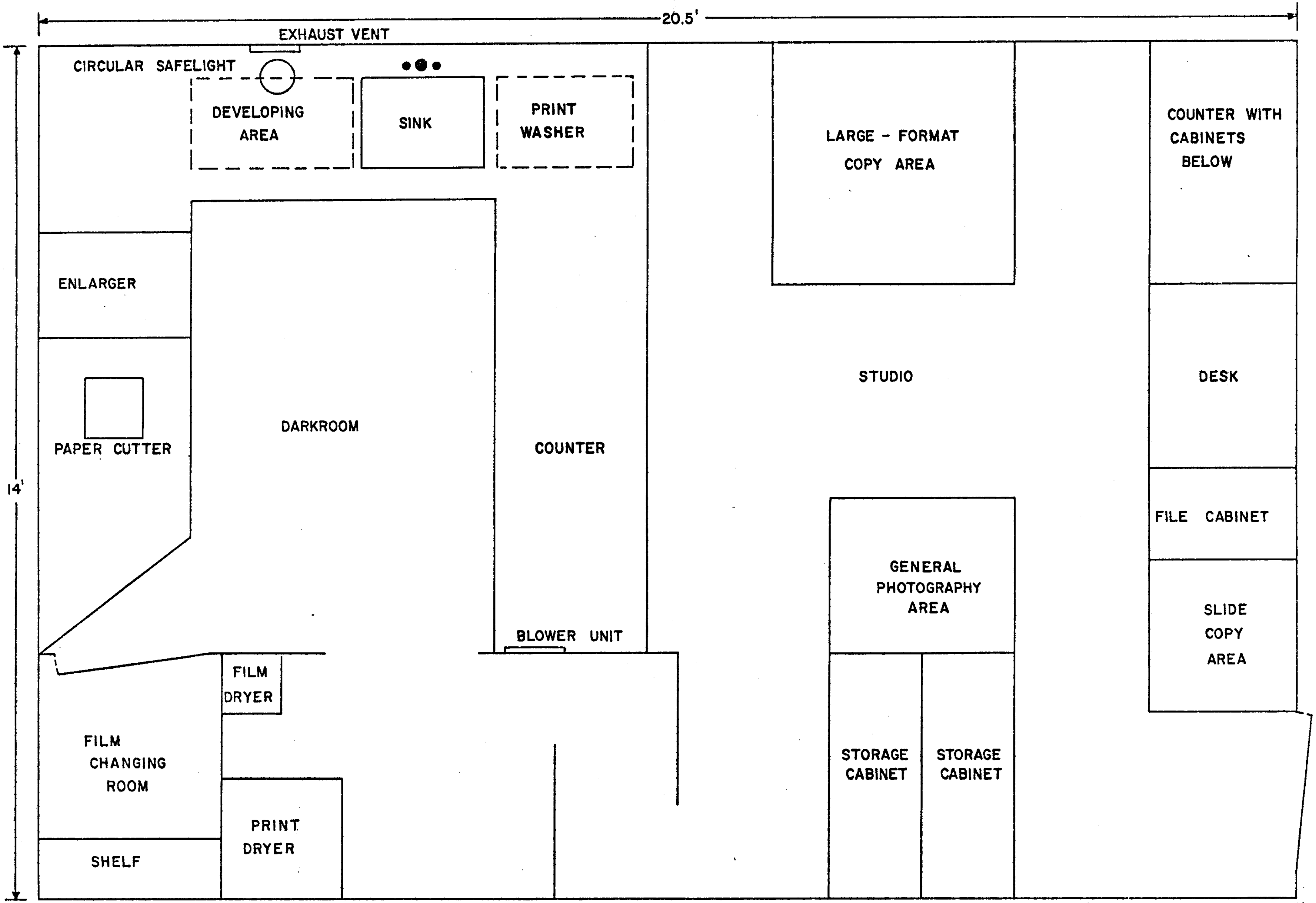


Diagram 3 Photographic facility for the Department of Geology and Mineralogy at The Ohio State University.

APPENDIX A - SURVEY

The following two pages show the materials that were sent to all the professors in the Department of Geology and Mineralogy at The Ohio State University. The return rate was 92%.

Category of Work	Total Estimated Production Per Quarter
5 x 7 black and white prints........................	206
$8\frac{1}{2}$ x 11 black and white prints......................	182
4 x 5 black and white polaroid prints..............	100
5 x 7 color prints.................................	101
$8\frac{1}{2}$ x 11 color prints................................	28
shoot and develop original color slides............	888 frames
shoot and develop copy color slides................	360 frames
shoot and develop copy black and white slides......	191 frames
copies of material for literature.................. (charts, diagrams, maps, etc.)	15
process black and white film.......................	402 frames
process color negative film........................	97 frames
process color slide film...........................	468 frames

Name_______________________________

Office_____________________________

Phone______________________________

Department of Geology & Mineralogy

I am currently working on a senior thesis involving an evaluation of geologic photographical techniques and equipment and the amount of photographic work needed to be carried out at a geology department of the size of that at The Ohio State University. The aim of this questionnaire is to supply me with a source of data for my senior thesis, and I would appreciate it if you would take the time and answer the questions below and then return the questionnaire to my mailbox in the Carman Room as soon as possible.

When answering the questions approximate all figures as closely as possible for each type of work you mark. Please be as specific as possible in your comments.

If the Department of Geology and Mineralogy had the facilities of a photographic laboratory and a technician to do quality work, what type and what quantity of work would you submit to the technician per quarter as an average?

	TYPE	QUANTITY	COMMENT
Prints	B & W 8½" x 11"		
	B & W 5" x 7"		
	B & W other		
	COLOR 8½" x 11"		
	COLOR 5" x 7"		
	COLOR other		
Slides	COLOR originals		
	COLOR duplicates		
	B & W duplicates		
Copies	Normal sizes		
	Larger sizes		
Processing	B & W negatives		
	COLOR negatives		
	COLOR slides		

Thank you,

Cecil W. Applegate Jr.

Cecil Applegate
Dept. of Geology & Mineralogy
125 S. Oval Drive

DEPARTMENT OF GEOLOGY & MINERALOGY

Several weeks ago I distributed a questionnaire pertaining to your needs of photographic work. This questionnaire will supply me with basic information for my senior thesis. To continue my research of topic I need the information from the questionnaire as soon as possible.

If you have not returned the questionnaire to my Carman Room mailbox would you please do so at your earliest convenience.

Thank you,

Cecil D. Applegate Jr.

Cecil D. Applegate, Jr.

APPENDIX B - COST OF EQUIPMENT

Darkroom:

Beseler 45 MCRX enlarger	$ 420
35-mm glassless negative carrier	11
$2\frac{1}{4}$ glassless negative carrier	11
4 x 5 glassless negative carrier	11
35-mm classless Negatrans carrier	50
50-mm f/4.0 Schneider Compound lens with lensboard	117
80-mm f/4.5 Schneider Compound lens with lensboard	117
135-mm f/5.6 Scheider Compound lens with lensboard	200
Paterson universal tank and reel	8
extra reel for Paterson tank	3
Paterson force film washer	2
Paterson 8 x 10 trays (set of 3)	4
Paterson 20 x 24 trays (set of 3)	50
Paterson 3" funnel	2
Paterson 5" funnel	3
Paterson 5 oz. graduate	2
Paterson 42 oz. graduate	4
Arkay 1620-A print washer	110
Total	$ 1,125

Studio:

Nikon F2 Photomic with 50-mm f/2.0 lens	$ 600
Nikon 55-mm f/3.5 micro lens	210
Nikon Bellows Attachment IV	148
Hasselblad 500 C/M with 80-mm f/3.5 lens	825

Linhof Kardan-color 4x5S (less lens)		$ 300
Acme-lite no. 600 Quartzflud (3200°K)		22
Acme-lite stand for Quartzflud		15
Beseler 1620 print dryer		465
	Total	$ 2,585

Darkroom cost	$ 1,125
Studio cost	2,585
Total facility cost	$ 3,710

NOTE: All prices are manufacturer's suggested retail price rounded to the nearest dollar value.

APPENDIX C - REFERENCES

By Author:

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